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AN ACCOUNT OF SOME EXPERIMENTS MADE IN 1823 AND 1824, FOR DETERMINING THE QUANTITY OF WATER FLOWING THROUGH DIFFERENT SHAPED ORIFICES. BY BRYAN DONKIN, ESQ., F. R. A. S., V. P. INST. C. E.

The apparatus employed in these experiments having been made for a different purpose than that of merely ascertaining the quantity of water discharged, occasioned the peculiar form which is here described.

A, in Fig. 1, Plate IV., represents a vertical copper pipe of $3\frac{3}{8}$ inches interior diameter.

B, a horizontal pipe of the same diameter, joined to the lower end of *A* by what is usually called a mitre joint.

C, another pipe, joined to *B* in a similar manner, but so contrived that it could be turned up or down into a vertical or horizontal position.

Fig. 2 represents the outer end of the pipe *C*, with a cap, *D D*, fitting closely upon its outer side, and capable of being put on or taken off at pleasure; upon the end of cap *D* the ring *d d* was soldered, being about $\frac{1}{4}$ inch wide; this cap was employed for securing the different shaped orifices to the pipe *C*. For instance, where the efflux of water through an aperture in a thin plate of metal was intended to be tried, the cap was taken off, and a circular plate *e e*, of a corresponding diameter to that of the exterior of the tube *C*, was applied to the end of *C*, and the cap *D D* put over it to secure it in its place.

To guard against any leakage of water between the joinings of the cap, the pipe, and the plate, the joinings were filled with a soft cement made of tallow and bees' wax.

Upon the upper end of the pipe *A*, a copper cistern, *E*, was fixed. This cistern was about 2 feet diameter and 6 or 7 inches in depth; the length of the pipe *B* was 10 feet; of *C* about 1 foot 9 inches, and of *A* about 25 feet, measuring from the top of *E* to its junction with *B*.

The water was supplied from a circular cistern, *F*, of 6 feet $7\frac{1}{2}$ inches diameter, and 2 feet 10 inches in depth, by means of a sluice *f*, and the trough *g*.

During each experiment a man was placed to regulate the sluice, so as to keep the cistern *E* always full. And in order to ascertain the quantity of water discharged, a float with a graduated stem was placed in the said cistern *F*.

On the 28th of November, 1823, the following experiments were made in the presence of Professor Barlow, of Woolwich.

To the end of the pipe *C*, the conical pipe *G* was applied, by having a thin plate, *h*, soldered to it; the opening at the smaller end, which was $\frac{1}{2}$ inch in diameter, and that of the large end $2\frac{1}{2}$ inches diameter, and its length 12 inches; the discharge took place from the larger end of the cone, whilst the pipes *C* and *G* were in a vertical position; the height of the column of water from its surface in *E*, to the upper end of the cone *G*, was 22 feet 9 inches In 4 minutes it discharged 12·25 cubic feet of water, being at the rate of 3·0625 cubic feet per minute.

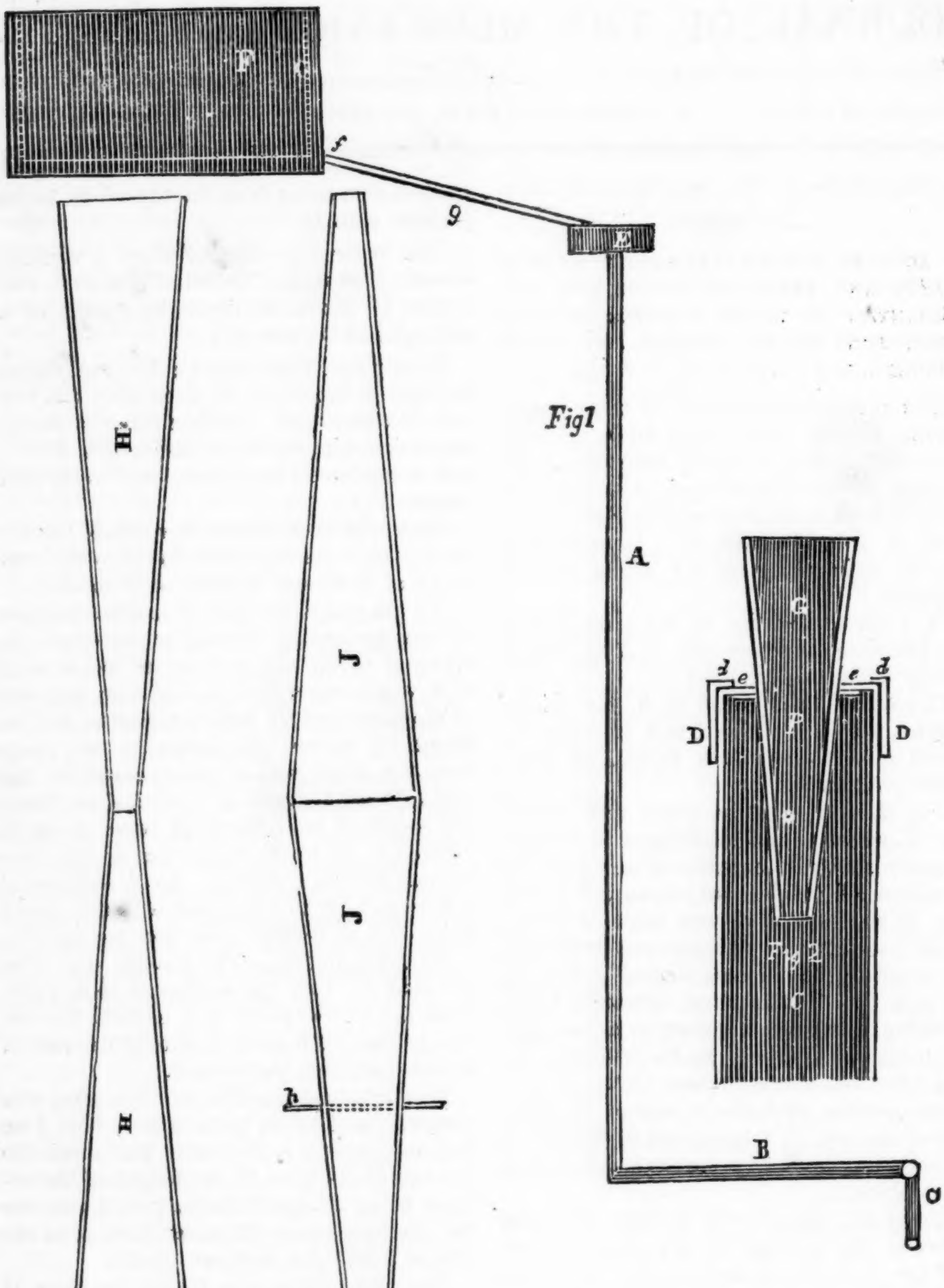
2d Experiment.—The conical pipe was inverted so that the discharge took place from the smaller end; in 4 minutes the discharge was 12·5 cubic feet, or at the rate of 3·125 cubic feet per minute.

3d Experiment.—The conical pipe was removed, and a thin plate with a hole $\frac{1}{2}$ an inch in diameter in its centre was applied to the end of the pipe *C*, the height of the column being 23 feet 3 inches; in 4 minutes the discharge was 8·2 cubic feet, or at the rate of 2·05 cubic feet per minute.

Nov. 29. The pipe *C* and the cone *G* were placed horizontally, with the smaller end of the cone outwards, and a column of 26 feet; in 8 minutes it discharged 26·8 cubic feet, being at the rate of 3·35 cubic feet per minute.

Dec. 1st. Pipe and cone horizontal, the

Plate 4.



larger end outwards, and 26 feet column; in 5 minutes discharged 15·4 cubic feet, or 3·08 cubic feet per minute.

Another experiment was continued for 8 minutes, and the discharge was at the rate of 3·09 cubic feet per minute.

Dec. 5. Two conical pipes, *H H*, each of which was of the same dimensions as the one above described, were united at their smaller ends, and applied to the pipe *C*; in 10 minutes the discharge through the double cone was 48 cubic feet, or at the rate of 4·8 cubic feet per minute, the column of water being 24 feet 3 inches.

A second experiment on the same day was made with a thin plate, having a ½ inch hole through it, and a column of 24 feet 3 inches; in 10 minutes the discharge was 20·6 cubic feet.

In a third experiment, the double cone was tried again, and the discharge obtained was 47·4 cubic feet in 10 minutes.

Dec. 8. The 2 conical pipes last mentioned were separated, and joined together at their larger ends, as at *J J*; in this form a discharge of 20·8 cubic feet of water was obtained in 10 minutes, under a column of 24 feet 3 inches.

Dec. 12. The thin plate with a ½ inch hole was again applied under a column of 24 feet 3 inches, and during 10 minutes discharged 20·75 cubic feet.

Same day. The single cone with the small end outwards, in 10 minutes discharged 32·2 cubic feet, and with the large end outwards, 29·7 cubic feet in the same time, under a head of 24 feet 3 inches.

Same day. The double cone united at their smaller ends, produced a discharge of 46·5 cubic feet in 10 minutes, and in 5 minutes 23·5 cubic feet.

June 8th, 1824. The discharge through the ½ inch round hole in the thin plate during 15 minutes, was 31·75 cubic feet, under a column of water of 24 feet 4 inches high = 2·116 cubic feet per minute.

June 9. Through the same hole, and under the same column, the discharge was 42 cubic feet in 20 minutes; = 2·1 per minute.

Through a round hole ¼ of an inch diameter, in a thin plate, the discharge was rather less than 16 cubic feet in 30 minutes, under a column of 25 feet 8½ inches.

June 10. The ½ inch hole through a thin plate gave a discharge of 65 cubic feet under a column of 25 feet 8½ inches in 30 minutes, at the rate of 2·166 cubic feet per minute.

The single cone, with the smaller enp outwards, delivered 58 cubic feet in 18 minutes, under a head of 25 feet 8½ inches; = 3·22 cubic feet per minute.

On a subsequent day in June. The same experiment repeated, and in 20 minutes the discharge was 63·33 cubic feet; = 3·166 cubic feet per minute. In this experiment, the small end of the cone was immersed about 6 inches below the surface of the water during the discharge, consequently the column was 25 feet 2½ inches.

Another experiment on the same day, with the same cone, having its larger end outwards, and immersed seven inches below the surface of the water, discharged 59 cubic feet of water in 20 minutes; = 2·95 cubic feet per minute.

The same experiment repeated during 10 minutes, gave a discharge of 29·46 cubic feet, or 2·946 cubic feet per minute.

In another experiment, the double cone joined at the smaller ends, in 18 minutes discharged 84·633 cubic feet under a head of 25 feet 9 inches; = 4·7 cubic feet per minute.

Another experiment. The same double cone with its axis 7 inches under water, and a column of 25 feet 2 inches, discharged 56·5 cubic feet in 12 minutes; = 4·7 cubic feet per minute.

ON VENTILATING AND LIGHTING TUNNELS, PARTICULARLY IN REFERENCE TO THE ONE ON THE LEEDS AND SELBY RAILWAY. BY J. WALKER, ESQ., F. R. S. L. AND E., PRESIDENT INST. C. E.

The want of ventilation and light seems the greatest objection to tunnels on railways and canals. An attempt is making to remedy both these evils in the tunnel now (1832) forming on the Leeds and Selby Railway, near Leeds, by a plan weich is simple, not attended with much expense, and likely to be at least partially successful. A short description will suffice to make it understood.

The tunnel is nearly half a mile long; the greatest depth from the surface about 80 feet. As three shafts were required for raising the excavation during the progress of the work, it occurred to me, that by placing them at nearly equal distances, and walling them in a permanent manner, they

might be left open to the surface afterwards. A strong elliptical casting, about 8 feet long and 5 feet wide, has therefore been built in the arch of the tunnel, and over this a circular shaft or well, 10 feet diameter, raised in strong brickwork. If it be found expedent to cover the well as a protection from the rain, it may be done with glass, raised on columns of such height as to admit a free circulation of air between the surface of the ground and the roof.

So much for ventilation. But as the light afforded by the shafts is confined to the space immediately below them, the desideratum is to throw it along the tunnel, and I think this may be done so as to give a useful light by means of plane reflectors of tinned iron placed on the ground between the two lines of railway, at such an angle as to reflect the light where it will be most useful. The idea was suggested by the rum vaults in the West India Docks where the marks on the casks are ascertained by catching the faint light from the windows upon a small piece of tin plate, and throwing it on the casks. Those who have seen this done have generally been surprised at the useful effect produced; but in the case of the tunnel, the light coming directly down the shaft is more powerful, and the effect of the experiments I have made has much exceeded my expectations. I shall take care that the results of any future observations be communicated to the Institution.

P. S.—In compliance with the promise given in the preceding paper, I have procured from Mr. George Smith, the resident engineer on the Leeds and Selby Railway, the annexed observations on the subject containing the result of his recent experience. Though they do not in all respects realize the expectations I had formed from the first experiments which were made before the tunnel was completed, or the railway formed, I may remark, that while the shafts seem to be very serviceable for ventilation, the light they supply is useful to those whose duties require them to pass through the tunnel on foot or unaccompanied with an engine. Mr. Smith's remarks are dated December 1835, and are as follows:—

"At the present period when there are "so many railways in progress and in contemplation, many of them with tunnels of "considerable length, the following observations on the effects of the Locomotive "Engines, working in the tunnel of the "Leeds and Selby Railway, may be interesting to those who have not the opportunity of witnessing those effects daily "and under all circumstances.

"The tunnel of the Leeds and Selby "Railway is nearly half a mile in length, "situated at the commencement of that railway at the Leeds end, and has a slight "ascending inclination in going from Leeds. "The situation and inclination cause a considerable difference in the quantity of "steam discharged from the chimneys of "two engines travelling in opposite directions.

"The ascending engine laboring at a "first start against the inclination, to get "into speed, (which is scarcely done before leaving the tunnel,) causes a great "expenditure of steam, &c., while an engine coming in the opposite direction, "having a clear fire, and every means taken "to prevent the generation of steam, by "opening the fire-door and pumping water "into the boiler, expends very little, and "that through the safety valve, the smoke "from the chimney not being perceptible. "It will therefore be necessary to detail the "effect of an engine passing through the "tunnel from the Leeds end only.

"The fires of the engines are made up, "previous to starting, with coke mixed "with coal, to hasten the ignition of the "former; the smoke from the coal is of "course mixed with that of the coke and "steam, adding to the density of what escapes from the chimney, and continues "to do so for some time, frequently through "the whole length of the tunnel: but notwithstanding this, the tunnel is generally "clear in less than five minutes after; in "many cases nearly as soon as the engine "has left it. This of course is governed, "in a great measure, by the force and direction of the wind. In foggy weather "there being little or no wind, the smoke "from the coal is left after the steam is "condensed, and forms itself into a cloud "which sails slowly along the roof, travelling at the rate of from two to three miles "per hour; a great part of it ascends the "shafts, but from the heavy state of the "atmosphere, a considerable portion passes

"them and discharges itself at one end of "the tunnel. It should here be mentioned, "that the entrances into the shaft from the "tunnel are much contracted, having not "more than 5 feet in the longitudinal, and "8 feet in the transverse direction of the "tunnel, and much of the smoke, &c., "passes on each side of the shafts; and in "consequence of the sluggishness of the "draught on those days, the lower part of "the cloud has not sufficient time to alter "its course up the shafts.*

"The engines, having coal mixed with "the coke in their fire-boxes, left the Leeds "depot during a very heavy morning, and "followed each other quickly through the "tunnel: each left a cloud behind, the one "keeping at a considerable distance from "the other. The smoke (the steam ap- "pearing to have been condensed) seemed "to have lost its usual sulphurous smell, "and resembled a dense fog—the dense- "ness appearing greater from the darkness "of the tunnel; and such is the freedom "of those clouds from any thing unpleasant, "that passengers in close carriages are not "aware of having passed through them, "which they do almost instantaneously.

"Passengers are never annoyed with the "steam, &c., from the chimneys of the "engines, as it does not descend low "enough, except on heavy days, and even "then, the progress of the engines carries "them forward before it is so low as to "affect them.

"From the effects described above, it "appears evident, that in tunnels situated "only a short distance from the starting- "place, it is extremely probable little or no "inconvenience will be felt by the passen- "gers passing through them.

"Previous to the opening of the Leeds "and Selby Railway, great doubts were "entertained by many, and among others "a celebrated lecturer, as to the fitness of "the atmosphere for respiration, in a tun- "nel worked by locomotive engines; now "that the incorrectness of that idea is fully "proved, as far as regards a tunnel half a "mile long, those doubts are still enter- "tained by many individuals, as to tunnels "of much greater lengths. These doubts "will probably prove as groundless as the "former ones, for the following reasons:—

"A considerable quantity of the steam "from the engines ascends the shafts at "all times, but there is no doubt a large "portion is also condensed in the tunnel; "and were there no shafts at all, the steam "could not remain long uncondensed, sur- "rounded, as it will ever be, by walls al- "ways at an even temperature, a short dis- "tance from the ends of the tunnel, satu- "rated with moisture, and the surface in "many parts covered with water.

"The coke, particularly when in a high "state of combustion, gives out little smoke, "and, from its having passed through the "steam, loses, like the coal, the greater "part, if not all its offensiveness; and "mixing with the air that has been used "for combustion, will, from its boyancy, "readily find its way along the top of the "tunnel to the first shaft, and make its "escape up it.

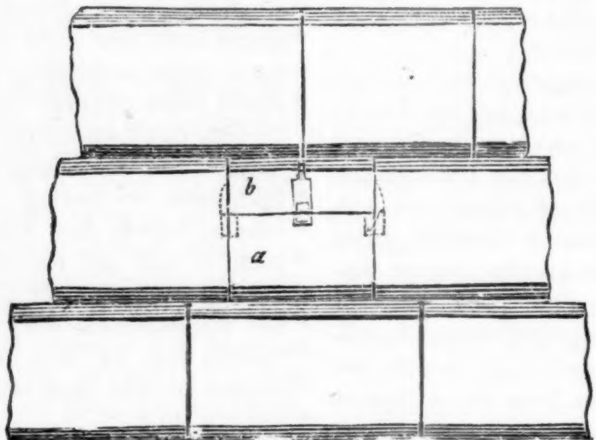
"Two great inconveniences in tunnels, "are noise and want of light; the former "it will be difficult to remedy, the latter "may be easily so, by carrying oil or porta- "ble gas lamps with the carriages. Oil "lamps are used with the evening trains, "during the winter months, on the Leeds "and Selby Railway, and give sufficient "light in their passage through the tunnel. "Some experiments were made with tin "reflectors at the bottom of the shafts, and "although the light reflected was sufficient "to read the larger print in a newspaper "advertisement at all parts of the tunnel, "(there being three shafts,) it is very doubt- "ful whether lighting tunnels by reflection "will be of use for passengers. The rays "of light are thrown on the walls so very "obliquely, that, from the rough and dirty "state of their surface, few are again re- "flected from them, and these are too "feeble for the eye to accommodate itself "to so great a transition during the time a "train would be passing through a tunnel "of moderate length. A passenger sitting "in a close carriage, having only the walls "to look at, would, under such circum- "stances, fancy himself in total darkness, "although the tunnel generally might be "moderately light. The difficulty of keep- "ing reflectors clean from the effects of "damp, steam, &c., would be a considera-

* This naturally suggests the propriety of having the shafts much larger, probably the same diameter as the width of the tunnel.

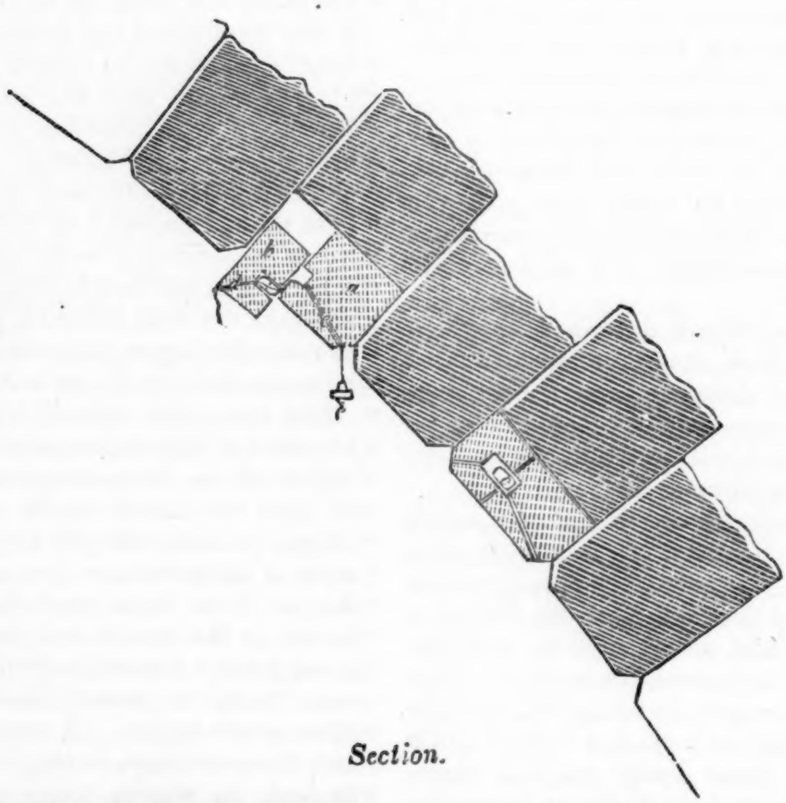
" ble expense in a long tunnel; and it must " also be borne in mind, that the moment " an engine has passed a reflector, it be- " comes of no use to the train attached to " that engine, as it is immediately sur- " rounded with steam, &c., forcing its way " up the shaft, and the next reflector, in a " long tunnel, would probably be a quarter " of a mile from the one thus thrown into " darkness."

Plate 5.

RESTORING ARCHSTONES AT BLACKFRIARS BRIDGE.



View of Soffit.


Section.

DESCRIPTION OF THE PLAN OF RESTORING THE ARCHSTONES OF BLACKFRIARS BRIDGE. BY JAMES COOPER, A. INST. C. E. COMMUNICATED IN A LETTER TO THE SECRETARY.

From the perishable nature of the material with which even the largest bridges were built, before the use of granite became so common as it has of late years in the more important structures of this kind, the best plan of repairing parts falling to decay, is a point of some consequence. With a view to contribute towards the stock of in-

formation on the subject, I beg to offer to the Institution the accompanying drawing (plate No. V), showing the mode that has been adopted by Messrs. Walker and Burges, of restoring the archstones of Blackfriars Bridge, with the following observations in explanation of it.

The decayed part is first cut out for the whole height of the course, to the depth of 15 inches generally, but in faulty places sometimes as much as 2 feet, and never in shorter lengths than a foot; and the beds and sides of the opening being dressed fair, moulds or templates are fitted into it to get the correct shape for the new work.

The stone is inserted in two thicknesses, the lower of which *a*, is dovetailed or radiated rather more than the original archstone, and the upper, *b*, slightly tapered like a wedge, to enable it to be driven; the dimensions of the two when put together making up the size of the cavity. Circular holes are sunk opposite each other in the adjoining beds of the two pieces to receive the dowel *c*, that in the lower part, *a*, being half the length of the dowel deep, while the corresponding hole in the part *b*, is deep enough to receive the dowel completely, so that when deposited in the hole, the dowel may offer no obstruction to getting the stone in; and from the bottom of these holes, openings, *d*, *e*, of about ¾ inch diameter are drilled to the chamfers on the face of the joints.

The dovatailed stone, *a*, is first set in mortar, and brought to a bearing on its bed, by wedging applied in the place afterwards to be occupied by the other half, *b*; which is next covered with mortar on the beds and joints, and driven in by wooden beetles until the circular holes in the beds come opposite each other, when, the cord *d* having been disengaged, the dowel *e* (held by it in the hole in the bed of the upper stone *b*) is drawn or pushed half its length into the stone *a*. Should the new stone be sufficiently in contact with the old work, which the sound from the beetle readily denotes, and be otherwise properly driven, mortar is rammed down the hole *d*, so as to surround the dowel and keep it in its proper place. The cord *e* for drawing the dowel home runs in a groove in the bed of the stone *a* from the dowel hole to the face of the archstone, and sometimes when it is not brought into action the dowel is pushed with a jointed piece of iron wire inserted through the opening *d* in the upper stone.

The wedge-formed stones, *b*, are usually 12 inches thick on the face, tapering off half an inch at the depth of 15 inches, and run from a foot to 2 feet 6 inches long, which they seldom exceed, as when thicker or longer they are found unwieldy to drive. These limitations are not, however, required in the dovetailed stone *a*, which is put in in as long lengths as are supplied, and its thickness is regulated by the cavity to be filled, the other stone, *b*, being, as has just been stated, generally uniform in this dimension. The dowels, which are of Craigleith stone, are 5 inches long and 3 inches diameter in the middle, diminishing to 2½ inches at the ends.

When the new stone is inserted, as has been described, and the dowel secured in its place, it is evident that neither half can drop out, and that on the hardening of the mortar, though *two* pieces, they become for practical purposes *one* archstone. But while the work is in progress, and before the stone *b* is put in, the dovetailed stone *a* has a tendency to slide out, which is sometimes met by strutting from the scaffolding, or by leava small tenon on the under side of the new stone fitting into a mortise in the masonry beneath; but within six or eight courses on either side of the crown of the arch, and in other places, when a considerable length has been taken out, a joggle *f*, 4 inches long by 2½ inches square, is inserted at each end of the new work, or in the case of a very short stone at one end only, being let from the upper bed of the stone *a* diagonally into the vertical joint between the new and the old work, so that half is in one and half in the other.

So far as I am aware, the above scheme is new, and it seems fully to meet the difficulties of the case; the new stones filling completely the hollows left by the old ones cut out, which from the radiation of the joints in an arch they could not if put in as one piece, and so giving a perfect bearing between the original and the restored work, while the whole is secured without injury to the adjoining masonry by external wedging or otherwise.

ON THE RELATION BETWEEN THE TEMPERATURE AND ELASTIC FORCE OF STEAM, WHEN CONFINED IN A BOILER CONTAINING WATER. BY MR. FAREY, M. INST. C. E.

This subject has occupied the attention

of many able experimenters, and the coincidence of the results which they have attained separately, leaves no doubt of the facts hereinafter stated.

Mr. Watt made experiments in 1764, and repeated them in 1774. Mr. Southern went over them again in 1797 with great accuracy, and formed a theorem for calculating the results; Dr. Robinson and M. Bettancourt also made similar experiments; likewise Mr. Dalton, Mr. Woolf, and Mr. Philip Taylor; also Dr. Ure.

The writer of this communication undertook, several years ago to compare all the different experiments which had then been made, in order to obtain a standard, and was induced, after a careful examination*, to adopt Mr. Southern's theorem as the most authentic, being found very consistent with itself, and being confirmed, at several points of the scale, by the actual experiments of others, although the complete scales promulgated by some of those others were very discordant, from having been interpolated between the actual experiments by incorrect theorems; and particularly some scales which had been extended by such theorems beyond the range of their actual experiments, were found to be very far from the truth. In consequence, Mr. Southern's scale was made the foundation of all the Writer's computations and statements respecting steam; many of which have since been published.

The principal object of the present communication is, to show the coincidence between Mr. Southern's scale, and that of a new series of experiments made in Paris, in 1829, by a Committee of the Academy of Sciences, which confirms the standard so completely, as to leave no doubt of its truth.

Another object of the communication is to put on record, in the papers of the Institution, a memorial of the fair claim of our countryman, Mr. Southern, to the merit of priority in accurate determination of this law, in opposition to the unfounded assertion of the French author, who has published the new experiments, that the academicians had first established the truth in 1829, and that the previous determinations in England were erroneous*. Mr. Southern's determination is not mentioned in this sweeping condemnation, although it had been republished by Mr. Watt, Dr. Brewster, Dr. Thomson, and in the Writer's Treatise on the Steam Engine, also in that of Mr. Tredgold, and is well known, and very generally adopted, in fact, by the French academicians themselves.

The French experiments were continued up to twenty-four atmospheres; Mr. Southern's went only as far as eight atmospheres; he found the corresponding temperature to be 343·8 degrees of Fahrenheit's thermometer, and the academicians found it to be 341·8 degrees, or just two degrees less. At four atmospheres, Mr. Southern found the temperature 293·9 degrees, and the academicians 293·7. This last is not an accidental coincidence, but an adoption of Mr. Southern s scale, through Mr. Tredgold, though not acknowledged as such.

The French academicians have formed a theorem for calculating the temperatures corresponding to the elasticities, and by

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* The mode of examination was that which Mr. Smeaton and Mr. Watt pursued in similar cases, viz., to form curves for representing each scale, the temperature, in degrees of the thermometer, being the ordinates, and the elasticities, in atmospheres, being the abscissæ of the curves.

* The French account of the occasion of making their experiments on the temperatures corresponding to different elasticities of steam, in 1829, contains the following passage:—"Science did not then possess this knowledge, and engineers appointed to superintend the construction of "steam engines, had no other guidance "than some discordant measures upon the "temperatures which correspond to the "elasticities between one and eight atmospheres; for higher pressures there was "no result of direct experiments, nor any "theory which could supply the deficiency."

It is afterwards stated that only one experiment by Mr. Perkins was obtained in England, and that is shown to be altogether erroneous; and then, that "Germany was more advanced than England, for the results in question, Mr. Arzberger, at Vienna, having made experiments," but they are also shown to be inexact.

means thereof have extended their scale from twenty-four atmospheres upwards; nevertheless, they did not use their own theorem for the most useful part of the scale below four atmospheres, but they adopted a theorem from Mr. Tredgold in lieu of their own.

That theorem was made by Mr. Tredgold, from Mr. Southern's experiments, in lieu of Mr. Southern's own theorem, merely because Mr. Tredgold did not think that a power with a fractional index, viz., 5·13, is likely to represent the law of nature. This induced him to employ a higher power, with 6 for an index; and in consequence, his formulæ did not correspond at all with Mr. Southern's experiment at eight atmospheres, although it did correspond at four atmospheres. The academicians use an index of 5 in their theorem, rendering it very nearly the same in effect as Mr. Southern's.

In adop ing this formula from Mr. Tredgold, (who quotes Mr. Southern's experiments, and takes them as his basis,) the French academicians could not have been ignorant of Mr. Southern's determinations, nor of their accuracy; for at eight atmospheres, his experiments and theorem is nearer to their own experiments than Mr. Tredgold's theorem, which they have adopted for that pa t of their scale which is below four atmospheres, and which theorem gives a result identical with Mr. Southren's theorem and experiments, at two and a half atmospheres, although Mr. Tredgold's becomes very incorrect below boiling, and also above four atmospheres.

Under these circumstances, it was not candid that all mention of Mr. Southern's determinations should have been suppressed, when in fact they are adopted at second hand, and through a less correct version than his own; and when it was found requisite to amend that version, and put it back very near to its original value, the author of that original should have been cited.

In a former report by the Academy in 1825, a Table was given, which is exactly Mr. Southern's numbers, and it would have been only fair, that his standard should have been acknowledged when adopted*. The

ed as " having merit of extending it, by further experiments, up to twenty-four atmospheres, in 1829, and thereby proving Mr. Southern's exactitude, is willingly acknowledged by the Writer of this communication, to be due to the French academicians.

When the temperature due to an elasticity of twenty-four atmospheres is calculated by Mr. Southern's theorem, it gives 438·2 degrees of Fahrenheit's thermometer, whilst the French experiment is 435·6, or only 2·6 degrees less; of this difference, some part is occasioned by the difference in the French and English mode of reckoning what an atmosphere is*. Again, for sixteen atmospheres, Mr. Southern's theorem gives 401·0 degrees,and the French experiment 368·5, or $2\frac{1}{2}$ degrees less. At eight atmospheres, 2 degrees less, as before stated.

These small differences are less than the inevitable uncertainties of observation in such experiments, and it is to be remarked, that the elasticities were measured by the French academicians by the compression of air included in a manometer, and not by a direct measure of a column of mercury, or a loaded safety valve; whereas Mr. Southern used both those means, and employed very correct thermometers, and therefore his scale is of as much authenticity as that of the French; and the Writer of this communication does not think it requisite to make any alteration in the standard which he adopted long ago for all his calculations on this subjects, and of which

* In the account of the experiments of 1829, the former Table of 1825,is mention-

" been only presented temporarily, and as " having been only deduced from interpola- " tion of all the experiments which seemed " to merit the most confidence, from the " ability of the observers, and from the na- " ture of the methods of observation;" but no mention is made of Mr. Southern, although the numbers are his.

* The French reckon an atmosphere to be equal to a column of mercury $\frac{76}{100}$ of a metre in height, which is only 29·92 inches, and the boiling point of their thermometer is adapted thereto, whereas, since about the commencement of the present century, the English have reckoned it to be 30 inches. This cirumstance accounts in some degree for their scale of temperatures differing from Mr. Southern's.

many are published in his Treatise on the Steam Engine, where the subject is fully explained; and it is only necessary to give an extract therefrom, in order to state Mr. Southern's determination of a correct scale.

"From the comparison of a great number of his experiments, Mr. Southern invented a method of calculating the elasticity of steam at different temperatures, when saturated with water; his method is embodied in the following rule, which will give results very nearly corresponding with the experiments.

"To find the elasticity of steam of any given temperature, that temperature being expressed in degrees of Fahrenheit's thermometer, and the elasticity being expressed by the height, in inches, of the column of mercury that the steam will support.

"Rule.—To the given temperature in degrees of Fahrenheit, add the constant temperature 51·3 degrees, and take out the logarithm of the augmented temperature from a table of logarithms; multiply that logarithm by the constant number 5·13, and from the product (which is a logarithm) deduct the constant logarithm 10·94123; then by the table of logarithms find the number corresponding to the remainder, (which is also a logarithm,) and that number is one-tenth of an inch less than the height required; therefore, by adding one-tenth of an inch to the said number, we have the proper height, in inches, of the column of mercury that the steam will support*.

"Example.—What is the elasticity of steam at 212 degrees of temperature? 212 deg + 51·3 deg = 263·3 deg; the logarith of that number is 2·42045, which × 5·13 = 12·4169; from this logarithm deduct the constant logarithm 10·94123, and the remainder is 1·47567; the number corresponding to this logarithm is 29·9 inches, and, adding one-tenth of an inch thereto, we have thirty inches of mercury for the required elasticity.

"The rule may be used conversely to find the temperature of steam of any given elasticity thus. Deduct one-tenth of an inch from the height in inches of the column of mercury; take out the logarithm of the diminished height, and add to it the constat logarithm 10·94123; then divide the sum of these logarithms by the constant number 5·13; and find the by Table of logarithms, the number which corresponds to the quotient: that number is 51·3 degrees more than the required temperature; therefore deduct 51·3 from the said number, and the remainder is the proper temperature in degrees of Fahrenheit.

"Example: What is the temperature of steam of an elasticity of 120 inches of mercury? 120 inc.—·1 = 119·9 inc. The logarithm of that number is 2·07882, to which add the constant logarithm 10·94123 = 13·02005, for the sum of the logarithms, which being divided by 5·13 constant number, gives 2·53802 quotient. The number corresponding to that logarithm is 345·2 degrees, from which deduct the constant temperature 51·3 degrees, and we have 293·9 degrees for the required temperature.

"The following Table has been calculated by Mr. Southern's theorem.

* "The effect of multiplying the logarithm by 5·13, is to raise the 5·13th power of the temperature, when augmented as above, and then the effect of deducting the constant logarithm 10·94123, is to divide the high power previously raised, by a very large number, viz, (87344 000 000) eighty-seven thousand three hundred and forty-four millions. The quotient resulting from this division of the high power, with the constant addition of one-tenth of an inch, is the required elasticity in inches of mercury."

" Temperature. Degrees of Farenheit.	Elasticity. Column of mercury; inches.
32 freezing	0·18
42	0·25
52	0·35
62	0·50
72	0·71
82	1·01
92	1·42
102	1·97
112	2·68
122	3·60
132	4·76
142	6·22
152	8·03
162	10·25
172	12.94
182	16 17
192	20·04
202	24·61
212 boiling.	30·00

These numbers are nearly identical with experiments.

	Temperature Degrees of Fahrenheit.	Elasticity. Column of mercury; inches.
212	212 =1 Atmos.	30·00
	222	36·32
	232	43·60
	242	52·20
250·5	250·2=2 Atmos.	60·00
	252	61·90
	262	73·00
	272	85·80
275·2	275 =3 Atoms.	90·00
	282	100·30
	292	116·70
293·7	293·9=4 Atmos.	120·00
	302	135·20
307·5	309·2=5 Atmos.	150·00
	312	156·00
	322	179·30
320·4	322·3=6 Atmos.	180·00
	332	205·40
331·7	333·7=7 Atmos.	410·00
	342	234·40
341·8	343·8=8 Atmos.	240·00"

These numbers are from the French Academicians.

Treatise on the Steam Engine, Vol. I. p. 72.

It is presumed that it has now been shown that English engiacers have, for more than 30 years past, been in possession of a standard scale, which is very accurate, and also of a theorem whereby the temperatcres corresponding to elasticities, exceeding 8 atmospheres, may be correctly represented, notwithstanding assertions to the contrary.

The complete scale laid down by the French Academicians is as follows.

Elasticities. Atmospheres.	Temperature in Degrees Fahrenheit. (These numbers are calculated according to Mr. Southern's rule, which proceeds by the 5·13th power.)	Temperature in Degrees Fahrenheit.
1	212.0	212·0
1½	233·7	234·0
2	250·2	250·5
2½	263·8	263·8
3	275·0	275·2
3½	285·0	285·1
4	293·9	293·7
4½	301·9	300·3
5	309·2	307·5
5½	316·0	314·2
6	322·3	320·4
6½	328·1	326·3
7	333·7	331·7
7½	338·9	336·9
8	343·8	341·8
9		350·8
10		358·9
11		366·8
12	376·3	374·0
13		380·7
14		386·9
15		392·9
16	401·0	398·5
17		403·8
18		408·9
19		413·8
20	421·1	418·5
21		423·0
22		427·3
33		431·4
24	438·2	435·6

Thus far (1 to 4 atmospheres) was calculated by Mr. Tredgold's rule, which proceeds by the 6th power.

These (4½ to 24 atmospheres) were calculated by the French Academicians' rule, which proceeds according the 5th power.

NOTE. At 4 atmospheres this complete scale changes its law of progression all at once, from the 6th power to the 5th power, which cannot be correct in principle. Neither the 6th power nor the 5th will give correct results in the lower part of the scale, between boiling and freezing, nor in the higher part of the scale. But Mr Southern's fractional power 5·13, applies without change throughout the whole range, from freezing up to the temperature of melting tin.

By examing the French scale, it appears to correspond with Mr. Southern's at 4 atmospheres within $\frac{2}{10}$ of a degree, but in advancing only to $4\frac{1}{2}$ atmospheres, it falls short $1\frac{6}{10}$ degrees therefrom, and yet, up at 24 atmospheres, the deficiency is but $2\frac{6}{10}$ degrees.

The French theorem is virtually to the same effect as that of Mr. Southern, for the logarithm of the elasticity in atmospheres is divided by 5 (instead of 5·13) in order to extract the 5th root, from which root unity, or 1, is to be deducted, and the remainder divided by the constant decimal ·7153, the quotient expresses the increase of temperature above boiling, in terms of the interval between freezing and boiling, that is, the said quotient expresses what fractional portion of 180 degrees of Fahrenheit, the temperature is above the boiling point.

This is by no means a convenient rule, and does not apply without modification to temperatures below boiling, which Mr. Southern's does most accurately. The French rule, if modified, becomes inaccurate.

The only question as to the law of progression in the French rule being better than that of Mr. Southern's, is whether the 5·13 power is more authentic than the 5th power. Now the Academicians found Mr. Tredgold's rule, which proceeds by the 6th power, did better than their own, between one and four atmospheres, but it will not correspond either at lower or higher parts of the scale, whilst Mr. Southern's corresponds accurately below, and very nearly throughout.

Mr. Southern's theorem is prefarable to any other for calculations concerning the heights of mountains, according to observations of the temperatures at which water is found to boil at their summits and at their bases.

On considering all these circumstances, we shall find good reasons for adhering to Mr. Southern's theorem, because it is unquestionably accurate in all the lower part of the scale below boiling, and also above the same, as far as experiments can be made with certainty; and the new experiments of the academicians prove, that at very high parts of the scale, it cannot be far from the truth; but as there is no certainty in the exactitude of either temperatures or elasticities, when so great as 438 degrees and 24 atmospheres, it is not advisable to adopt a new law of progression for the sake of reconciling differences of $2\frac{1}{2}$ degrees from uncertain observations, when that new law will not correspond so well as the established law, with very certain and unquestionable observations.

67, Guildford Street, Russell Square,
1 May, 1833.

P. S. It would be useful information, if some of the junior members, who have leisure, would undertake to calculate the temperatures according to Mr. Southern's rule, for every half atmosphere between 8 atmospheres and 24 atmospheres, now that the French experiments have shown that his rule will apply to such an extent with very probable accuracy.

MODE OF SUPPORTING THE POOR IN BELGIUM.—Viscount Vilain XIII, who has been long appointed Minister at Rome, has resigned his office as Governor of East Flanders. Before quitting Ghent, Viscount Vilain addressed a circular to the different functionaries under his government, in which are some interesting details relating to the operations of the charitable workshops (*ateliers de charite*), established in different parts of Flanders. He states that the number of these institutions amounts to forty-three; that the total prime cost of material and salary paid to the poor amounts to 176,378 francs, and the same of manufactured articles to 162,583 francs, leaving a loss upon the whole of only 13,804 francs. Thus, at the expense of 13,804 francs, provision and employment have been given to 2265 poor people during the whole of the winter and part of the spring; and thus, at the trifling expense of six francs per person, forty-three parishes have been rescued from the evils of mendicity, and a large body of poor creatures, who must otherwise have begged or starved, have been actively and usefully employed, and have had the means of support-

ing their families without other parochial relief. The letter adds, that the average loss of six francs only arises from defective administration in some of the parishes, since it results that, in twenty-five out of forty-three, the loss has not exceeded two francs, and indeed in some of these has not been more than eighty centimes per person. In seven parishes the receipts nearly balance the expense, so that the poor have cost little or nothing; and in four parishes the returns have exceeded the expense, so as to leave a balance in the hands of the directors after supporting all the poor. These are remarkable results, and are well worthy the attention of the philanthropists in England and Ireland; for what can be more praiseworthy, more advantageous or honorable to the community, than the establishment of institutions by which pauperism, idleness, and immorality are neutralized without expense, and by which a number of persons who would be otherwise thrown upon the public workhouse, or become burdens to the parish, are actively employed, and encouraged in habits of industry and economy? Viscount Vilain earnestly recommends the establishment of similar worshops throughout the whole country. Were he able to effect his benevolent object, he would obtain one of the most important and most beneficial results ever effected in a civilized nation; and Belgium would present the phenomenon of a whole population purged, as it were, of idleness and pauperism. Whilst upon the subject, it may be observed, according to official statistical documents, published by order of the minister of the interior, that the total gross amount of the revenue of hospitals, charitable establishments, and of the divers sums expended upon the poor, amounted, in 1833, to 11,647,000 francs, or about 285 francs per individual. The number of the poor in the provincial workhouses has been reduced from 3454 in 1827, to 2662 in 1833, a remarkable diminution, seeing that the population has increased in an inverse ratio, naving augmented from 3,800,000 in 1827, to 4,061,000 in 1833. The same document states, that the total number of persons receiving instruction at the various colleges, schools, and places of education of all denominations, amounted altogether to 353,342 in 1826, whereas in 1833 the number of children attending the 5229 primary schools alone exceeded 370,000. If the progress of education had been great, the diminution of immorality is not less striking, for one finds the number of foundlings (*enfans trouves*) to have amounted to 11,023 in 1823, whilst in 1833 they did not exceed 7997. This is not a place to develope subjects of this kind, but the above examples will suffice to show, that Belgium is making considerable progress in those branches of administration and general morality which are the most essential to the well-being of a nation. It must not be omitted to state, that the tables in question give the population to the 1st of January 1835 at 4,165,953 souls; the superfices of the soil at 3,420,570 hectares (each 2½ acres), of which 381,470 hectares, or about one-tenth, are uncultivated, not including more than 100,000 hectares or 1–34th of roads and canals. In France, the uncultivated land, out of a superfices of 52,570,000 hectares, amounts to 9,000,000, or one-sixth; and the roads, canals, streets, &c. to 1,216,746, or one-fifth; both of which show a remarkable balance in favor of Belgium.—[Qr. Journal of Agriculture.]

ALGERINE MORTAR.—The mortar used by the ancients in their buildings has always been highly praised as much superior to that of the moderns. Pananti, a recent Italian writer on Algiers, paid a good deal of attention to the subject when residing in Africa, supposing it probable, from the well known stationary character of Oriental habits, that the ancient method of preparing it might be preserved there, though lost in Europe. He informs us, that the mortar used at Algiers is made of two parts wood-ashes, three parts lime, and one part sand—to this composition they give the name *Tabbi*. After mixing these ingredients together, they throw in a quantity of *oil*, and beat the whole together for three days and nights without intermission, by which time it has attained the proper consistence. After being used in building, it becomes harder than marble, is impermeable to water, and resists the operation of Time and the elements.

A NEW METHOD OF PLAYING THE VIOLIN.—A Monsieur Isoard has constructed a violin to be played by a pair of bellows. The performer holds the instrument after the manner of the violincello; his feet work the bellows, and his right hand directs the stream of air to the string requiring it.—[Musical World.]

MECHANICS' INSTITUTE.

The annual election of the Mechanics' Institute took place on Monday evening, 10th inst., when the following officers were elected for the ensuing year, viz:

George Bruce, President.

John M. Dodd, 1st Vice President.

Henry Cunningham, 2d Vice President.

George L. Spencer, Rec. Secretary.

Leonard D. Gale, Cor. Secretary.

William Everdell, Treasurer.

DIRECTORS.

James J. Mapes,	Richard Bragaw,
Thomas Ewbank,	Clarkson Crolius, Jr.,
Henry G. Stetson	Henry B. Robertson,
Henry Durell,	T. W. Bartholomew,
Sylvanus S. Ward,	John Bidley,
A. F. Cammeyer,	Oliver Whittlesey,
William J. Mullen,	Abraham J. Mason,
Jordan L. Mott,	Loring D. Chapin,
Martin W. Emmons,	William B. Worrall,
Peter Wemmel,	Jacob S. Anderson,
Abraham Storms,	William Ballard,
Hiram Tupper,	George F. Nesbit.

Items.

Expeditious Calculation.—The actuary of a savings' bank in the neighborhood of Fitzroy square, has invented a machine for expeditiously and accurately calculating the interest due to depositors, the value of which may be deduced from the following particulars:—The accounts open on the 20th November, 1835, were 2,421, and occupied the late actuary four weeks.—The accounts open on the 20th November, 1836, were 2,734, and occupied the present actuary only 74 hours. An opinion may be formed of the assistance given by the machine from the following detail of the miutiæ necessary to arrive at the materials for the annual return required from savings' banks by the Commissioners for the reduction of the National Debt. The time taken to calculate the interest on 2,734 accounts, to enter it on the ledgers, to make the additions, to rule the lines, to take out each account under its proper classification, and to take out the folies of 4,292 closed accounts, amounted to 74 hours, making an average of $9\frac{1}{4}$ hours for each of the eight ledgers, or 91 accounts per hour.

Succory Coffee.—Succory root, cut, root, dried, torrefied, and ground to powder, is most extensively employed as a substitute for coffee, or rather, I ought to say, to adulterate coffee. A full account of the preparation of it will be found in the *Annales des Chemie*, lix. p. 307. Its consumption is so great, that some fear has been expressed of its seriously injuring trade in, and cultivation of, coffee; and the Chancellor af the Exchequer has prepared to lay a tax on it. I am told that it is employed very largely by grocers to adulterate their coffee, by coffee-house keepers, and by economical house-keepers. It yields a perfectly wholesome and agreeable beverage, but wants that fine aromatic flavor peculiar to coffee, and for which the latter is celebrated.—[Mr. Perira's Lectures in the Medical Gazette.]

Wear of Carriage Wheels.—It has been calculated, by an engineer of eminence, that every four horse coach deposites 12 lb. of iron in every 100 miles of its journey, and that consequently, assuming the number of such coaches passing daily between London and Birmingham alone to be 20, the weight of iron deposited during every transit exceeds 240 lbs. These results, it is stated, are not conjectural, but derived from investigations applied to the horse-shoe and the tire of the wheel—in the first instance, previously to use; and, in the second, after the wear and tear of the road had rendered them useless; and they have been found, it is added, as to every ton weight of iron so tried, nearly uniform.

Busts and Portraits.—A new instru-

ment has been invented in Paris, called the Phisiognotype, for the moulding of busts, on a principle which renders the likeness to the original a mechanical certainty. Busts in plaster are thus produced for five francs each. Another machine, entitled the Portrait-mirror, has also been constructed, by which a portrait may be taken in twenty minutes, from the reflection of the face of the original in a looking-glass.—[Athenæum.]

STRONG METAPHOR.—Two brothers recently from the old country, via Halifax, were lately walking up the Worcester Railroad, and their curiosity was some what astonished by the iron tracks, but soon the cars hove in sight, and the following dialogue took place:

Michael.—Och brither; d'ye see that quare cr-crachure a coming?

Patrick.—Troth an' I do. What, in the divil and his grandmother does it mane?

Michael.—Faith, an' it's not me that is to tell ye, but dont an'ye stand out of the way, ye'll learn quite satisfactorily, I'm thinking. Don't ye min' how hard he brathes—he must have been running right tightly for a long space.—[*The car whizz'd by.*]

Patrick.—Och, Mike, we're completely lost; for by my mother's milk, ***it is Hell in harness,*** and just the sort of coach I once dreamt the ould divil took the morning air in!

MORUS MULTICAULIS NOT PRODUCED FROM ITS OWN SEEDS.

The following statement agrees with what we were first to inform our countrymen of, in this journal, more than two years ago, on the authority of an experiment reported in the ***Annales de l'Agriculture Francaise,*** that the *morus multicaulis* had been found to be merely a variety of white mulberry, and did not reproduce its own kind by seeds. This very important fact (if true) we have again and again endeavored to impress on the agricultural public—but apparently to no purpose. The anxiety to obtain seeds of the *morus multicaulis* has been so great, that encouragement has been thereby afforded to extensive frauds, by the seller substituting seeds of another kind. But even if the seeds had been what they were supposed to be, if from trees of the true *multicaulis,* the failure and disappointment would probably have been as great.

But though believing that the seeds of this plant are not to be relied on for reproducing their own kind, we are not inclined in any case to trust to reported opinions, or authority that is the least doubtful, when the facts can be tested by accurate experiment. We have the means of making such an experiment, in seeds of the *morus multicaulis* taken last summer from trees which grew within the enclosure of the high walls which surround the Penitentiary of Virginia, and near which no other kind of mulberry grew, to affect the seeds by a mixture of the fecundating farina. If *these seeds* will not produce the *morus multicaulis,* it may be thereafter safely pronounced, that seeds are not only not to be relied on to produce this kind, but that the result of reproduction of the like kind rarely, if ever, occurs.

"This mulberry, it is now well ascertained, is a hybrid variety, and not a true species—the seed will not produce its like. We have been informed by a gentleman who purchased a plant, three or four years since, of some nurserymen of our vicinity, that with considerable care he raised quite a number of seeds. The plant was taken up upon the appearance of severe weather, and placed in a cellar where the frost did not penetrate—the roots were slightly covered with earth. Pursuing this course two succeeding winters, it attained the size of a large shrub with numerous ramifying branches—the third season it produced seeds. No other species or variety grew in the vicinity of the plant, and the blossoms consequently could not have been fertilized but by its own pollen. These seeds were carefully sown, and the result was a number of seedling plants, with foliage of all sizes and textures from the common white, to that of the parent. No better proof is needed to confirm what we now state, and have heretofore stated."

[American Gardener's Magazine.]

SHOES IMPERVIOUS TO WATER.—The following description of a patent lately taken out, is from the ***Franklin Journal.***—"The soles may be made of plaited flax, hemp,

or the inner bark of the linden tree. For the upper part any kind of cloth may be used, and the shoes lined with linen or cotton. The soles are then varnished or covered with the following composition:—One quart of flax-seed oil, two ounces of rosin, half an ounce of white vitriol, which must be boiled together for half an hour After which take four ounces of spirits of turpentine, and two ounces of white oak saw-dust, which has been exposed twenty-four hours to the sun; mix these ingredients well together, and put them on the soles of the shoes with a brush or in any other way, which, when dried, will render them impervious to water."

A Machine on a new principle, for raising Water, Coals, &c.—The construction of this power is very simple, and its steady operation is quite assured. Its chief agent is a pair of wheels; or, if necessary, a series, moving with their diameters in the direction of the weight to be raised,—say the shaft of a mine. Taking the one pair of wheels, moving on the same axis, we find that, from the end of a radius or arm in each, a chain descends, so as to hang on opposite sides of a square passage. To each chain are suspended at different but regulated distances, quadrangular frames, to the upper sides of which strong projecting iron rims, moving on the principle of the hinge, are attached. The boxes, or receptacles for the weight to be raised, have corresponding edges on each side. When the wheel above is turned, and a single box below is placed in connexion with the lowest frame, it is caught by its rim, and, with one revolution of the wheel, is sent up as high as the frame on the opposite side to that on which it is borne; here it is again caught and sent up to the apparatus on the opposite side again, and so on, by alternate transmission, it is brought to the top of the shaft. The machine being kept constantly laden below, and its wheel constantly turned above, it follows, that, at each revolution of the wheel, a box is delivered; and thus, in an exceedingly short space of time, a vast body of matter can be carried up through any depth of shaft. The raising of water is performed by means of the same machinery, only buckets with valves in the bottom are used instead of boxes. The machine could be most humanely employed, in large mines, in quickly sending the workmen up or down, to save them from their present tedious and tiresome expedients for that purpose.—[Mining Journal.]

Interesting to Blacksmiths.—Permit me to describe a machine which I have just seen, and which, for utility and simplicity, is truly admirable. The article I allude to is a substitute for a smith's bellows, and is far more powerful than the kind in common use. It is constructed in the way of fanners, and stands immediately behind the forge. The box of the implement is only eighteen inches diameter, and the fans which fill the box are only five inches broad, and are fastened upon a horizontal shaft of $\frac{3}{4}$-inch iron. On the end of the shaft is a pulley two inches diameter, and right above which is a larger pulley twenty-inches diameter, with a crank in the centre, which the man at the fire drives with one hand, while he guides the iron in the fire with the other. Around the large pulley and down to the small one is a leathern belt, by which this machine is driven, and with such ease that a child may drive it. The blast is so constant and so efficient, that the contriver prefers it for heavy work to the best bellows, which cost him 6*l*., while he has the blast-bellows for about 30*s*; and he adds, that, for a few more shillings, he could have it driven by wind. Although bellows on the same plan have been used and driven by steam and by water at our large iron-works, yet the merit of constructing one to work with the hand, belongs to Mr. William Bowle, blacksmith, Lower Bridge-street, Stirling. What adds much to the value of this contrivance is, its being easily purchased, that it requires little room, and is in many respects superior to the kind in common use. I hope, therefore, the sons of Vulcan will duly appreciate the contrivance.—[Correspondent of the Stirling Journal.]

Instrument applicable to various diseases of the Lungs.—A. M. Maissiat has submitted to the French Academy of Sciences an instrument, by which he proposes to convey liquids into the cavities of the lungs, or extract from it any gas, or liquid, to hold it in a state of dilatation, &c., as circumstances may require. He has also invented and laid before the same body another instrument, which is an improvement upon cupping glasses, and may entirely supersede the use of leeches.